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THE INTERNATIONAL
METRIC SYSTEM
OF WEIGHTS AND
MEASURES

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THE INTERNATIONAL METRIC SYSTEM OF WEIGHTS AND MEASURES.

INTRODUCTION.

The following was prepared to answer some of the more simple questions addressed to the Bureau of Standards in regard to the metric system of weights and measures and its use.

The essential features of the system were embodied in a report made to the French National Assembly by the Academy of Sciences in 1791. A number of other nations were invited to cooperate with France in establishing the new system, and Holland, Denmark, Switzerland, Spain, and several minor States were represented on an international commission which met in Paris in 1799 to accept the metric standards constructed under the direction of the French Institute.

Although the metric system very soon attracted the favorable attention of other nations, it was not until forty years later that its use became general in France. Since 1840, however, its use has rapidly spread until at the present time it is either obligatory or permissive in every civilized country in the world. Its use was made "lawful throughout the United States" by act of Congress in 1866, and at the same time provision was made to supply every State in the Union with a set of metric weights and measures.

No organized effort had been made up to this time to supply the different countries with authentic copies of the metric prototypes which were preserved in the archives of France. In order to meet the demand for accurate standards whose relation to one another would be known with the highest precision, metric conventions were held in Paris in 1870 and 1872, which were attended by official delegates from about thirty countries. At these conferences committees were appointed to investigate the best form and material

for the proposed new standards. In 1875 a treaty was signed at Paris by seventeen of the principal nations of the world, the United States being among the number, which provided for the permanent organization of an International Bureau of Weights and Measures under the direction of an International Committee. The most important work of the International Committee was to provide for the construction of a sufficient number of platinum-iridium meters and kilograms to meet the demand of the interested nations. The comparison of all these standards with one another and with the original meter and kilogram was made at the International Bureau which had been established near Paris on neutral territory ceded to the International Committee by the French Government.

This work was completed in 1889, and after selecting a certain meter and a certain kilogram as the international prototypes, the others were distributed by lot to the different countries. The international meter and kilogram^a have values identical with the original meter and kilogram, are preserved in a special underground vault at the International Bureau, and are accessible only to the International Committee. The United States secured two meters and two kilograms, which are now preserved at the Bureau of Standards at Washington and serve as the fundamental standards of length and mass of the United States. It is the plan of the International Committee to intercompare all the national meters and kilograms with the international prototypes at regular intervals or whenever considered necessary.

At the present time the International Bureau of Weights and Measures is maintained jointly by the following countries, under the terms of the Metric Convention, a treaty agreed upon May 20, 1875: Argentina, Austria, Belgium, Brazil, Bulgaria, Canada, Chile, Denmark, Finland, France and Algeria, Germany, Great Britain and Ireland, Hungary, Italy, Japan, Mexico, Norway, Peru, Portugal, Roumania, Russia; (Kingdom of) Serbs, Croats, and Slovenes; Siam, Spain, Sweden, Switzerland, United States, and Uruguay.

The advantages claimed for the metric system are:

- (1) The decimal relation between the units.
- (2) The extremely simple relation of the units of length, area, volume, and weight to one another.
- (3) The uniform and self-defining names of units.

^aThe original meter and kilogram "of the Archives" were adopted as standard in 1799.

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SYNOPSIS OF THE SYSTEM.

The fundamental unit of the metric system is the METER—the unit of length. From this the units of capacity (LITER) and of weight (GRAM) were derived. All other units are the decimal subdivisions or multiples of these. These three units are simply related; e. g., for all practical purposes one CUBIC DECIMETER equals one LITER and one LITER of water weighs one KILOGRAM. The metric tables are formed by combining the words “METER,” “GRAM,” and “LITER” with the six numerical prefixes, as in the following tables:

PREFIXES		MEANING		UNITS
milli-	= one thousandth	$\frac{1}{1000}$.001	“meter” for length,
centi-	= one hundredth	$\frac{1}{100}$.01	
deci-	= one tenth	$\frac{1}{10}$.1	
Unit = one			1	“gram” for weight or mass,
deka-	= ten	$\frac{10}{1}$	10	“liter” for capacity.
hecto-	= one hundred	$\frac{100}{1}$	100	
kilo-	= one thousand	$\frac{1000}{1}$	1000	

UNITS OF LENGTH.

milli-meter	=	.001	meter.
centi-meter	=	.01	“
deci-meter	=	.1	“
METER ^a	=	1	“
deka-meter	=	10	“
hecto-meter	=	100	“
kilo-meter	=	1000	“

Where *miles* are used in England and the United States for measuring distances, the *kilometer* (1,000 meters) is used in metric countries. The kilometer is about 5 furlongs. There are about 1,600 meters in a statute mile, 20 meters in a chain, and 5 meters in a rod.

^a One meter equals 39.37 inches exactly.

The *meter* is used for dry goods, merchandise, engineering construction, building, and other purposes where the *yard* and *foot* are used. The meter is about a tenth longer than the yard.

The *centimeter* and *millimeter* are used instead of the *inch* and its fractions in machine construction and similar work. The centimeter, as its name shows, is the hundredth of a meter. It is used in cabinet work, in expressing sizes of paper, books, and many cases where the inch is used. The centimeter is about two-fifths of an inch and the millimeter about one twenty-fifth of an inch. The millimeter is divided for finer work into tenths, hundredths, and thousandths.

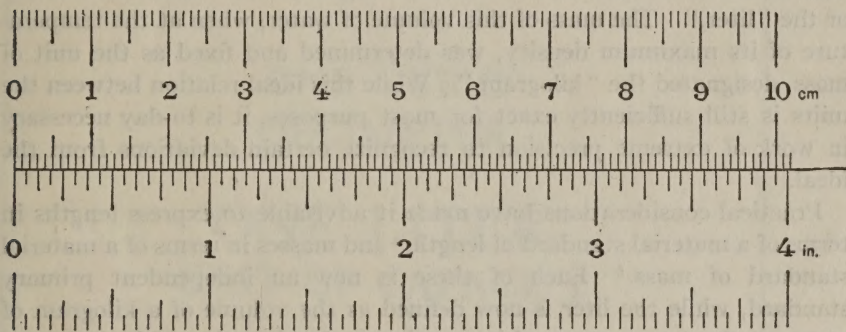


FIG. 1. COMPARISON SCALE: 10 CENTIMETERS AND 4 INCHES. (ACTUAL SIZE.)

If a number of distances in millimeters, meters, and kilometers are to be added, reduction is unnecessary. They are added as dollars, dimes, and cents are now added. For example, "1,050.25 meters" is not read "1 kilometer, 5 dekameters, 2 decimeters, and 5 centimeters," but "one thousand and fifty meters, twenty-five centimeters," just as "\$1,050.25" is read "one thousand and fifty dollars, twenty-five cents."

AREA.

The table of areas is formed by squaring the length measures, as in our common system. For land measure 10 meters square is called an "ARE" (meaning "area"). The side of one *are* is about 33 feet. The HECTARE is 100 meters square, and, as its name indicates, is 100 ares, or about $2\frac{1}{2}$ acres. An *acre* is about 0.4

hectare. A standard United States *quarter section* contains almost exactly 64 hectares. A *square kilometer* contains 100 hectares.

For smaller measures of surface the *square meter* is used. The square meter is about 20 per cent larger than the *square yard*. For still smaller surfaces the *square centimeter* is used. A *square inch* contains about $6\frac{1}{2}$ square centimeters.

VOLUME.

The units of the metric system at the outset were derived from the single unit of length, the "meter." This was defined as one ten-millionth part of the earth's quadrant, the length of the standard being determined by a geodetic survey. A cube one-tenth meter on a side was defined to be the unit of volume, designated the "cubic decimeter" or the "liter." The mass of this volume of water, when at the temperature of its maximum density, was determined and fixed as the unit of mass, designated the "kilogram." While this ideal relation between the units is still sufficiently exact for most purposes, it is to-day necessary in work of extreme precision to recognize certain deviations from the ideal.

Practical considerations have made it advisable to express lengths in terms of a material standard of length,^a and masses in terms of a material standard of mass.^b Each of these is now an independent primary standard, while the liter is now defined as the volume of a kilogram of water at the temperature of its maximum density, the cubic decimeter being, as originally, a cube one-tenth meter on a side.

The exact relation between the liter and the cubic decimeter, as nearly as it has been possible to determine it,^c is

$$1 \text{ liter} = 1.000027 \text{ cubic decimeters.}$$

The agreement is remarkable when one considers the limited facilities that were available for the making of precise measurements at the time the metric system was originated.

^a The International Prototype Meter.

^b The International Prototype Kilogram.

^c Trav. et Mém. du Bureau International des Poids et Mesures, XIV; 1910.

The cubic measures are the cubes of the linear units. The *cubic meter* (sometimes called the *stère*, meaning "solid") is the unit of

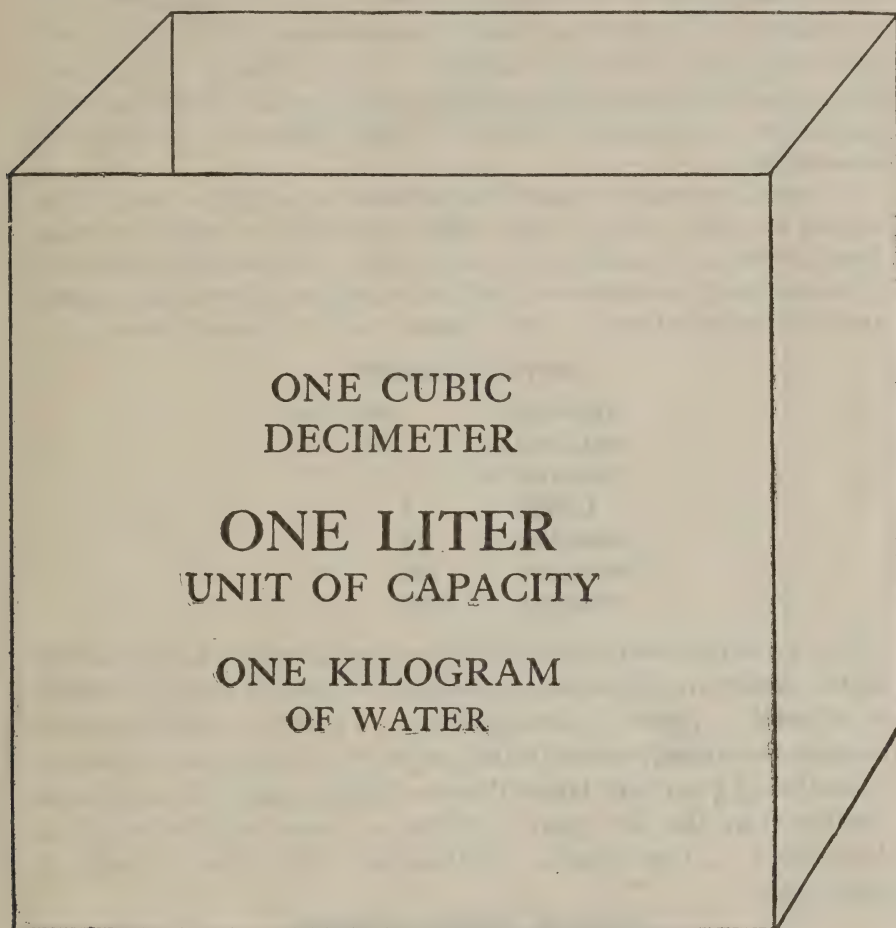


FIG. 2. CUBIC DECIMETER. (ACTUAL SIZE.)

[For precise relation between liter and cubic decimeter see equivalent on page 6.]

volume. A *cubic meter* of water weighs a *metric ton* and is equal to 1 *kiloliter*. The cubic meter is used in place of the cubic yard and is about 30 per cent larger. This is used for "cuts and fills" in grading land, measuring timber, expressing contents of tanks and reservoirs, flow of rivers, dimensions of stone, tonnage of ships, and other places where the cubic yard and foot are used. The thousandth part of the cubic meter is called the *cubic decimeter*. (See table of capacity units.)

For small volumes of liquids the *milliliter* (cc or ml) is used. This volume of water weighs a *gram*, which is the unit of weight or mass. There are about 16 milliliters in a cubic inch. The milliliter is the unit of volume used by chemists as well as in pharmacy, medicine, surgery, and other technical work. One thousand milliliters make 1 liter.

UNITS OF CAPACITY.

milli-liter =	.001	liter
centi-liter =	.01	"
deci-liter =	.1	"
LITER ^a =	1	"
deka-liter =	10	"
hecto-liter =	100	"
kilo-liter =	1000	"

The *hectoliter* (100 liters) serves the same purposes as the United States *bushel* (2,150.42 cubic inches), and is equal to about 3 bushels, or a barrel. A *peck* is about 9 liters. The liter is used for measurements commonly given in the *gallon*, the liquid and dry *quarts*, a liter being 5 per cent larger than our liquid quart and 10 per cent smaller than the dry quart. A *liter* of water weighs exactly a *kilogram*, i. e., 1,000 grams. A thousand liters of water weigh 1 metric ton.

UNITS OF WEIGHT (OR MASS).

milli-gram =	.001	gram
centi-gram =	.01	"
deci-gram =	.1	"
GRAM =	1	"
deka-gram =	10	"
hecto-gram =	100	"
kilo-gram ^b =	1000	"

^a One liter equals 1.05671 liquid quarts or 0.9081 dry quart.

^b One kilogram equals 2.204622 avoirdupois pounds.

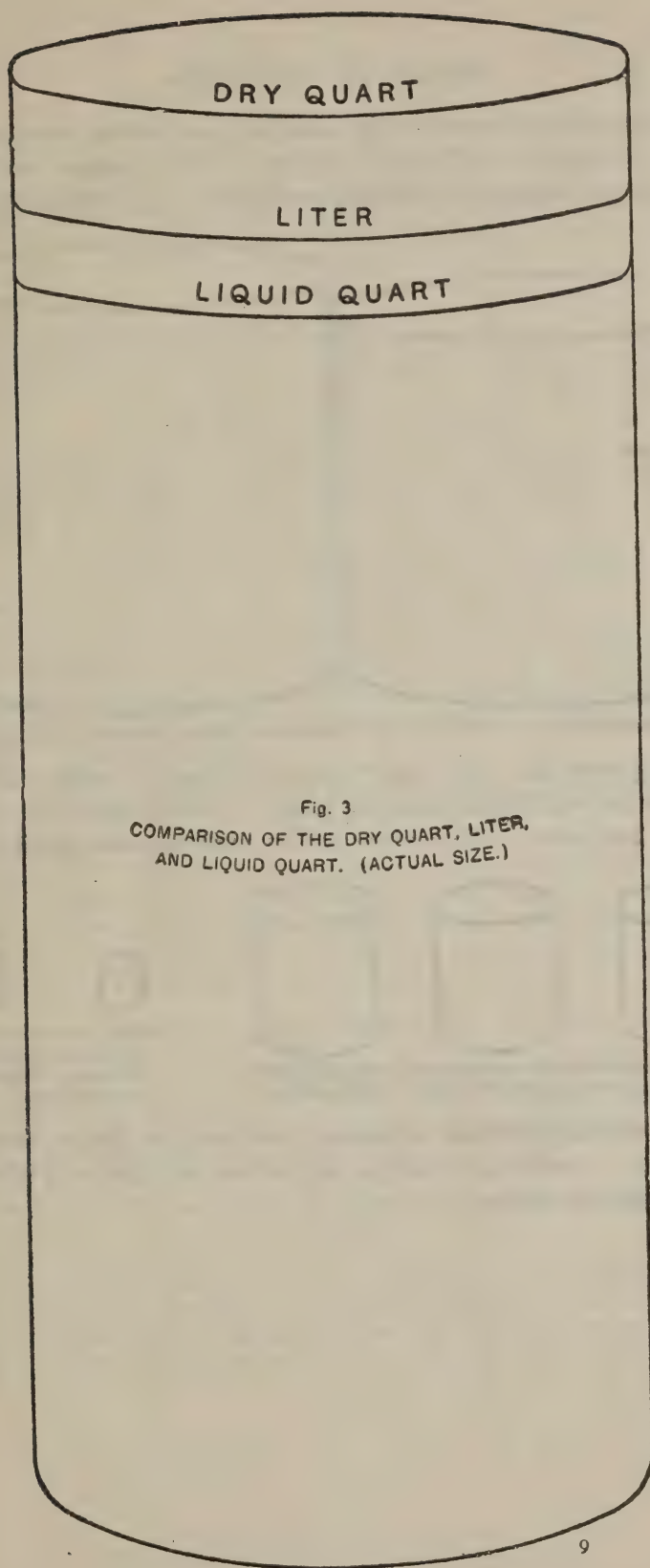


Fig. 3
COMPARISON OF THE DRY QUART, LITER,
AND LIQUID QUART. (ACTUAL SIZE.)

Measurements commonly expressed in *gross tons* or *short tons* are stated in *metric tons* (1,000 kilograms). The metric ton comes between our long and short tons and serves the purpose of both.



FIG. 4. RELATIVE SIZE OF 2-POUND AND 1-KILOGRAM (BRASS) WEIGHTS. (ACTUAL SIZE.)

The *kilogram* and "half kilo" serve for everyday trade, the latter being 10 per cent larger than the pound. The kilogram is approximately 2.2 pounds. The *gram* and its multiples and divisions are



FIG. 5. RELATIVE SIZE OF AVOIRDUPOIS OUNCE, 30-GRAM, AND TROY OUNCE (BRASS) WEIGHTS. (ACTUAL SIZE.)



FIG. 6. RELATIVE SIZE OF GRAM AND SCRUPLE (BRASS) WEIGHTS. (ACTUAL SIZE.)

used for the same purposes as ounces, pennyweights, drams, scruples, and grains. For foreign postage, 30 grams is the legal equivalent of the avoirdupois ounce.

STATUS OF THE INTERNATIONAL METRIC SYSTEM IN THE UNITED STATES.

"The Congress shall have power to * * * fix the standard of weights and measures." (Constitution of the United States.)

THE METRIC SYSTEM LEGALIZED.

"It shall be lawful throughout the United States of America to employ the weights and measures of the metric system." (Revised Statutes of the United States, sec. 3569, 1866.)

THE METRIC STANDARDS ADOPTED AS FUNDAMENTAL.

"* * * the office of weights and measures * * * will in the future regard the international prototype meter and kilogram as fundamental standards, and the customary units, the yard and the pound, will be derived therefrom in accordance with the act of July 28, 1866." (Order approved by the Secretary of the Treasury, April 5, 1893.)

FOREIGN POSTAL RATES BASED ON METRIC WEIGHTS.

"The Postmaster-General shall furnish to the post-offices exchanging mails with foreign countries, and to such other offices as he may deem expedient, postal balances denominated in grams of the metric system, fifteen grams of which shall be the equivalent for postal purposes, of one-half ounce avoirdupois, and so on in progression." (Revised Statutes of the United States, sec. 3880.)

METRIC WEIGHTS USED IN THE COINAGE.

"The weight of the half-dollar shall be twelve grams and one-half of a gram; the quarter-dollar and the dime shall be, respectively, one-half and one-fifth of the weight of said half-dollar." (Revised Statutes of the United States, sec. 3513.)

CONGRESS PROVIDES METRIC STANDARDS FOR THE STATES OF THE UNION.

"Be it resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That the Secretary of the Treasury be, and he is hereby, authorized and directed to furnish to each State, to be delivered to the governor thereof, one set of the

standard weights and measures of the metric system for the use of the States, respectively." (Joint resolution of Congress approved July 27, 1866. A joint resolution was also passed by Congress March 3, 1881, directing the Secretary of the Treasury "to cause a complete set of all the weights and measures adopted as standards to be delivered to the governor of each State in the Union, for the use of agricultural colleges in the States, respectively, which have received a grant of lands from the United States, and also one set of the same for the use of the Smithsonian Institution.")

UNITED STATES JOINS IN ESTABLISHING INTERNATIONAL BUREAU.

"The high contracting parties engage to establish and maintain, at their common expense, a scientific and permanent international bureau^a of weights and measures, the location of which shall be at Paris." (Extract from convention of 1875, signed for the United States by the United States ambassador to France.)

CONGRESS ADOPTS THE METRIC UNITS FOR ELECTRICAL MEASURES.

It was enacted by the Senate and House of Representatives that the international electrical units based on the metric system "shall be the legal units of electrical measure in the United States." (Revised Statutes of the United States, Supplement, vol. 2, chap. 131, 1894.)^a

METRIC SYSTEM REQUIRED IN THE MEDICAL WORK OF THE NAVY DEPARTMENT.

"The metric system of weights and measures shall hereafter be employed in the Medical Department of the Navy." (Order approved by the Secretary of the Navy, April 15, 1878.)

METRIC SYSTEM REQUIRED IN MEDICAL WORK OF WAR DEPARTMENT.

"All requisitions, invoices, receipts and returns, pertaining to medical supplies will be in accordance with the metric system of weights and measures. After the 30th day of June, 1894, the use of this system in writing official prescriptions is desired; on and after the 1st day of January, 1895, such use is hereby ordered." (Order approved by Secretary of War April 13, 1894.)

^a This bureau has the custody of the international standards of the metric system, to which all metric prototypes of the world are referred for verification. It was established and is maintained jointly by all the principal governments of the world.

METRIC SYSTEM MADE OBLIGATORY IN PORTO RICO.

"1. The use of the metrical system of weights and measures and its nomenclature are obligatory.

"2. Its use is enforced in all transactions, sales, contracts. * * *

"3. Wholesale and retail mercantile establishments shall sell their goods to the public conformably to the metric system." (Proclamation of military governor, March 18, 1899, Department of Porto Rico.)

METRIC SYSTEM OPTIONAL IN PORTO RICO.

"SECTION 1.—That the metric system of weights and measures, and the imperial system customarily used in the United States in so far as the same is described by this act, are hereby recognized and established in Porto Rico for use in all industrial and commercial transactions, * * *."

(Act No. 135, approved, August 18, 1913.)

METRIC SYSTEM MADE THE LEGAL SYSTEM IN THE PHILIPPINE ISLANDS.

"The metrical system of weights and measures as authorized by sections 3569 and 3570 of the Revised Statutes of the United States and at present in use in the Philippine Islands shall be continued." (Act No. 230, September 17, 1901, sec. 9, Philippine Tariff.)

METRIC SYSTEM REQUIRED IN UNITED STATES PUBLIC HEALTH AND MARINE-HOSPITAL SERVICE.

"Officers shall, for all official, medical, and pharmacal purposes, make use of the metric system of weights and measures. In expressing quantities by weight the terms of 'gram' and 'centigram,' and in expressing quantity by measure the term 'cubic-centimeter,' only shall be employed." (Regulation promulgated by the President November 21, 1902.)

COMPARISON OF METRIC AND CUSTOMARY UNITS FROM 1 TO 9

1. LENGTH

Inches (in.)	Millimeters (mm)	Feet (ft.)	Meters (m)	Yards (yd.)	Meters (m)	Rods (rd.)	Meters (m)	U.S. miles (mi.)	Kilometers (km)
0.039 37=1		1=0.304 801		1=0.914 402		0.198 838=1		0.621 370=1	
0.078 74=2		2=0.609 601		2=1.828 804		0.397 677=2		1.242 740=2	
0.118 11=3		3=0.914 402		3=2.743 205		0.596 515=3		1.864 110=3	
0.157 48=4		4=1.219 202		4=3.657 607		0.795 354=4		2.485 480=4	
0.196 85=5		5=1.524 003		5=4.572 009		0.994 192=5		3.106 850=5	
0.236 22=6		6=1.828 804		6=5.486 411		1.193 030=6		3.728 220=6	
0.275 59=7		7=2.133 604		7=6.400 813		1.391 869=7		4.349 590=7	
0.314 96=8		8=2.438 405		8=7.315 215		1.590 707=8		4.970 960=8	
0.354 33=9		9=2.743 205		9=8.229 616		1.789 545=9		5.592 330=9	
1= 25.4001		3.280 83=1		1.093 611=1		1= 5.029 21		1= 1.609 347	
2= 50.8001		6.561 67=2		2.187 222=2		2=10.058 42		2= 3.218 694	
3= 76.2002		9.842 50=3		3.280 833=3		3=15.087 63		3= 4.828 042	
4=101.6002		13.123 33=4		4.374 444=4		4=20.116 84		4= 6.437 389	
5=127.0003		16.404 17=5		5.468 056=5		5=25.146 05		5= 8.046 736	
6=152.4003		19.685 00=6		6.561 667=6		6=30.175 26		6= 9.656 083	
7=177.8004		22.965 83=7		7.655 278=7		7=35.204 47		7=11.265 431	
8=203.2004		26.246 67=8		8.748 889=8		8=40.233 68		8=12.874 778	
9=228.6005		29.527 50=9		9.842 500=9		9=45.262 89		9=14.484 125	

2. AREA

Square inches (sq. in.)	Square centimeters (cm ²)	Square feet (sq. ft.)	Square meters (m ²)	Square yards (sq. yd.)	Square meters (m ²)	Acres (A.)	Hectares (ha)	Square miles (sq. mi.)	Square kilometers (km ²)
0.155 00=1		1=0.092 90		1=0.8361		1=0.4047		0.3861=1	
0.310 00=2		2=0.185 81		2=1.6723		2=0.8094		0.7722=2	
0.465 00=3		3=0.278 71		3=2.5084		3=1.2141		1.1583=3	
0.620 00=4		4=0.371 61		4=3.3445		4=1.6187		1.5444=4	
0.775 00=5		5=0.464 52		5=4.1807		5=2.0234		1.9305=5	
0.930 00=6		6=0.557 42		6=5.0168		6=2.4281		2.3166=6	
1.085 00=7		7=0.650 32		7=5.8529		7=2.8328		2.7027=7	
1.240 00=8		8=0.743 23		8=6.6890		8=3.2375		3.0888=8	
1.395 00=9		9=0.836 13		9=7.5252		9=3.6422		3.4749=9	
1= 6.452		10.764=1		1.1960=1		2.471=1		1= 2.5900	
2=12.903		21.528=2		2.3920=2		4.942=2		2= 5.1800	
3=19.355		32.292=3		3.5880=3		7.413=3		3= 7.7700	
4=25.807		43.055=4		4.7839=4		9.884=4		4=10.3600	
5=32.258		53.819=5		5.9799=5		12.355=5		5=12.9500	
6=38.710		64.583=6		7.1759=6		14.826=6		6=15.5400	
7=45.161		75.347=7		8.3719=7		17.297=7		7=18.1300	
8=51.613		86.111=8		9.5679=8		19.768=8		8=20.7200	
9=58.065		96.875=9		10.7639=9		22.239=9		9=23.3100	

3. VOLUME

Cubic inches (cu. in.)	Cubic centimeters (cm ³)	Cubic feet (cu. ft.)	Cubic meters (m ³)	Cubic yards (cu. yd.)	Cubic meters (m ³)	Cubic inches (cu. in.)	Liters (l)	Cubic feet (cu. ft.)	Liters (l)
0.061 02=1		1=0.028 317		1=0.7646		1=0.016 386 7		1= 28.316	
0.122 05=2		2=0.056 634		2=1.5291		2=0.032 773 4		2= 56.633	
0.183 07=3		3=0.084 951		3=2.2937		3=0.049 150 2		3= 84.949	
0.244 09=4		4=0.113 268		4=3.0582		4=0.065 546 9		4=113.265	
0.305 12=5		5=0.141 585		5=3.8228		5=0.081 933 6		5=141.581	
0.366 14=6		6=0.169 902		6=4.5874		6=0.098 320 3		6=169.898	
0.427 16=7		7=0.198 219		7=5.3519		7=0.114 707 0		7=198.214	
0.488 19=8		8=0.226 536		8=6.1165		8=0.131 093 8		8=226.530	
0.549 21=9		9=0.254 853		9=6.8810		9=0.147 480 5		9=254.846	
1= 16.3872		35.314=1		1.3079=1		61.025=1		0.035 315=1	
2= 32.7743		70.629=2		2.6159=2		122.050=2		0.070 631=2	
3= 49.1615		105.943=3		3.9238=3		183.075=3		0.105 946=3	
4= 65.5486		141.258=4		5.2318=4		244.100=4		0.141 262=4	
5= 81.9358		176.572=5		6.5397=5		305.125=5		0.176 577=5	
6= 98.3220		211.887=6		7.8477=6		366.150=6		0.211 892=6	
7=114.7101		247.201=7		9.1556=7		427.175=7		0.247 208=7	
8=131.0973		282.516=8		10.4635=8		488.200=8		0.282 523=8	
9=147.4845		317.830=9		11.7715=9		549.225=9		0.317 839=9	

4. CAPACITY—LIQUID MEASURE

U. S. fluid drams (fl. dr.)	Milli- liters (ml)	U. S. fluid ounces (fl. oz.)	Milli- liters (ml)	U. S. liquid pints (pt.)	Liters (l)	U. S. liquid quarts (qt.)	Liters (l)	U. S. gallons (gal.)	Liters (l)
0.270 52=1		0.033 815=1		1=0.473 17		1=0.946 33		0.264 18=1	
0.541 04=2		0.067 629=2		2=0.946 33		2=1.892 67		0.528 36=2	
0.811 55=3		0.101 444=3		3=1.419 50		3=2.839 00		0.792 53=3	
1.082 07=4		0.135 259=4		4=1.892 67		4=3.785 33		1.056 71=4	
1.352 59=5		0.169 074=5		5=2.365 83		5=4.731 67		1.320 89=5	
1.623 11=6		0.202 888=6		6=2.839 00		6=5.678 00		1.585 07=6	
1.893 63=7		0.236 703=7		7=3.312 17		7=6.624 33		1.849 24=7	
2.164 14=8		0.270 518=8		8=3.785 33		8=7.570 66		2.113 42=8	
2.434 66=9		0.304 333=9		9=4.258 50		9=8.517 00		2.377 60=9	
1=3.6966		1=29.573		2.1134=1		1.056 71=1		1=3.785 33	
2=7.3932		2=59.146		4.2268=2		2.113 42=2		2=7.570 66	
3=11.0898		3=88.719		6.3403=3		3.170 13=3		3=11.356 00	
4=14.7865		4=118.292		8.4537=4		4.226 84=4		4=15.141 33	
5=18.4831		5=147.865		10.5671=5		5.283 55=5		5=18.926 66	
6=22.1797		6=177.437		12.6805=6		6.340 26=6		6=22.711 99	
7=25.8763		7=207.010		14.7939=7		7.396 97=7		7=26.497 33	
8=29.5729		8=236.583		16.9074=8		8.453 68=8		8=30.282 66	
9=33.2695		9=266.156		19.0208=9		9.510 39=9		9=34.067 99	

5. CAPACITY—DRY MEASURE

U. S. dry quarts (qt.)	Liters (l)	U. S. pecks (pk.)	Liters (l)	U. S. pecks (pk.)	Deka- liters (dcl)	U. S. bushels (bu.)	Hecto- liters (hl)	U. S. bushels per acre	Hecto- liters per hectare
0.9081=1		0.113 51=1		1=0.8810		1=0.352 38		1=0.8708	
1.8162=2		0.227 03=2		2=1.7619		2=0.704 77		2=1.7415	
2.7243=3		0.340 54=3		3=2.6429		3=1.057 15		3=2.6123	
3.6324=4		0.454 05=4		4=3.5238		4=1.409 53		4=3.4830	
4.5405=5		0.567 56=5		5=4.4048		5=1.761 92		5=4.3538	
5.4486=6		0.681 08=6		6=5.2857		6=2.114 30		6=5.2245	
6.3567=7		0.794 59=7		7=6.1667		7=2.466 68		7=6.0953	
7.2648=8		0.908 10=8		8=7.0477		8=2.819 07		8=6.9660	
8.1729=9		1.021 61=9		9=7.9286		9=3.171 45		9=7.8368	
1=1.1012		1=8.810		1.1351=1		2.8378=1		1.1484=1	
2=2.2024		2=17.619		2.2703=2		5.6756=2		2.2969=2	
3=3.3036		3=26.429		3.4054=3		8.5133=3		3.4453=3	
4=4.4048		4=35.238		4.5405=4		11.3513=4		4.5937=4	
5=5.5060		5=44.048		5.6756=5		14.1891=5		5.7421=5	
6=6.6072		6=52.857		6.8108=6		17.0269=6		6.8906=6	
7=7.7084		7=61.667		7.9459=7		19.8647=7		8.0390=7	
8=8.8096		8=70.477		9.0810=8		22.7026=8		9.1874=8	
9=9.9108		9=79.286		10.2161=9		25.5404=9		10.3359=9	

6. MASS

Grains (gr.)	Grams (g)	Apothe- caries' drams (dr. ap. or ʒ)	Grams (g)	Troy ounces (oz. t.)	Grams (g)	Avoirdu- pois ounces (oz. av.)	Grams (g)	Avoirdu- pois pounds (lb. av.)	Kilo- grams (kg)
1=0.064 799		0.257 21=1		0.032 151=1		0.035 274=1		1=0.453 59	
2=0.129 598		0.514 41=2		0.064 301=2		0.070 548=2		2=0.907 18	
3=0.194 397		0.771 62=3		0.096 452=3		0.105 822=3		3=1.360 78	
4=0.259 196		1.028 82=4		0.128 603=4		0.141 096=4		4=1.814 37	
5=0.323 995		1.286 03=5		0.160 754=5		0.176 370=5		5=2.267 96	
6=0.388 794		1.543 24=6		0.192 904=6		0.211 644=6		6=2.721 55	
7=0.453 592		1.800 44=7		0.225 055=7		0.246 918=7		7=3.175 15	
8=0.518 391		2.057 65=8		0.257 206=8		0.282 192=8		8=3.628 74	
9=0.583 190		2.314 85=9		0.289 357=9		0.317 466=9		9=4.082 33	
15.4324=1		1=3.8879		1=31.103		1=28.350		2.204 62=1	
30.8647=2		2=7.7759		2=62.207		2=56.699		4.409 24=2	
46.2971=3		3=11.6638		3=93.310		3=85.049		6.613 87=3	
61.7294=4		4=15.5517		4=124.414		4=113.398		8.818 49=4	
77.1618=5		5=19.4397		5=155.517		5=141.748		11.023 11=5	
92.5941=6		6=23.3276		6=186.621		6=170.097		13.227 73=6	
108.0265=7		7=27.2155		7=217.724		7=198.447		15.432 36=7	
123.4589=8		8=31.1035		8=248.828		8=226.796		17.636 98=8	
138.8912=9		9=34.9914		9=279.931		9=255.146		19.841 60=9	

OFFICIAL ABBREVIATIONS OF INTERNATIONAL METRIC UNITS

used by the Bureau of Standards conformably to the principle followed in the abbreviations adopted by the International Committee on Weights and Measures, October 2, 1879. (Procès-Verbaux des Séances de 1879, Comité International des Poids et Mesures; vol. IV, p. 41; 1880.)

PREFIXES		UNITS	
	k kilo-	m	meter
	h hecto-	g	gram
	dk* deka-	l	liter
	d deci-	a	are
	c centi-		
	m milli-		

LINEAR (length)	SQUARE (area)	CUBIC (volume)
km kilometer	km ² square kilometer	km ³ cubic kilometer
hm hectometer	hm ² square hectometer	hm ³ cubic hectometer
dkm dekameter	dkm ² square dekameter	dkm ³ cubic dekameter
m meter	m ² square meter	m ³ cubic meter
dm decimeter	dm ² square decimeter	dm ³ cubic decimeter
cm centimeter	cm ² square centimeter	cm ³ cubic centimeter**
mm millimeter	mm ² square millimeter	mm ³ cubic millimeter
μ micron (=0.001 mm)	μ^2 square micron	μ^3 cubic micron

MASS*** (weight)	SURFACE (land area)	CAPACITY (of containers)
kg kilogram		kl kiloliter
hg hectogram	ha hectare	hl hectoliter
dkg dekagram		dkl dekaliter
g gram	a are	l liter
dg decigram		dl deciliter
cg centigram	ca centare	cl centiliter
mg milligram		ml milliliter**

NOTE.—A similar plan is used for abbreviations of cgs units and others. mf milli-farad (m milli, f farad); μ f microfarad; $m\mu$ a thousandth of a micron, and $\mu\mu$ one millionth of a micron. (See Guillaume: Unités et Étalons, p. 7, note.)

**“dk” suggested and used by Bureau to distinguish from “d”.

***“cc” is often used c.

****“t”=metric ton=1000 kg.

DATE-IN

4/10/79

DATE-OUT

FEB 28 1989

CALL NO.

LOC.

NO.

☐ RUSH☐ SER. REC. RTG.☐ BOUND BEFORE☐ NOT BOUND BEFORE☐ VOL. IS COMPT.

CEASED WITH

MISSING ITEMS:

RETN. FOR COMMERCIAL
BINDING ☐

OTHER

☐ RARE, SCARCE, — HANDLE CAREFULLY☐ PAMPHLET☐ W/POCKET☐ LOOSELEAF☐ PAD BINDS☐ REGULAR☐ PAD FOR LOC.☐ L.U.M.☐ INSERT☐ MAKE POCKET☐ TREAT LEATHER☐ C.C. SHEETS☐ DISINFECT☐ PAPER CONSERVATION WORK☐ WASH☐ DEACIDIFY☐ MEND: PP, SIGNATURES, MAPS☐ MEND: ARCHIVAL TAPE, HEAT TISSUE,
JAPANESE PAPER☐ MOUNT: CHARTEX, PAPER, CLOTH☐ ENCAPSULATE☐ CONTAINERS☐ FOLDING STORAGE CONTAINER A☐ FOLDING STORAGE CONTAINER B☐ CLOTH BOX☐ BOOK REPAIRS☐ GLUE HINGES☐ REHANG☐ POKE IN☐ HALF BACK☐ SAVE SPINE☐ COMPLETE BIND

COLOR _____

☐ SEW: Tape, cords

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